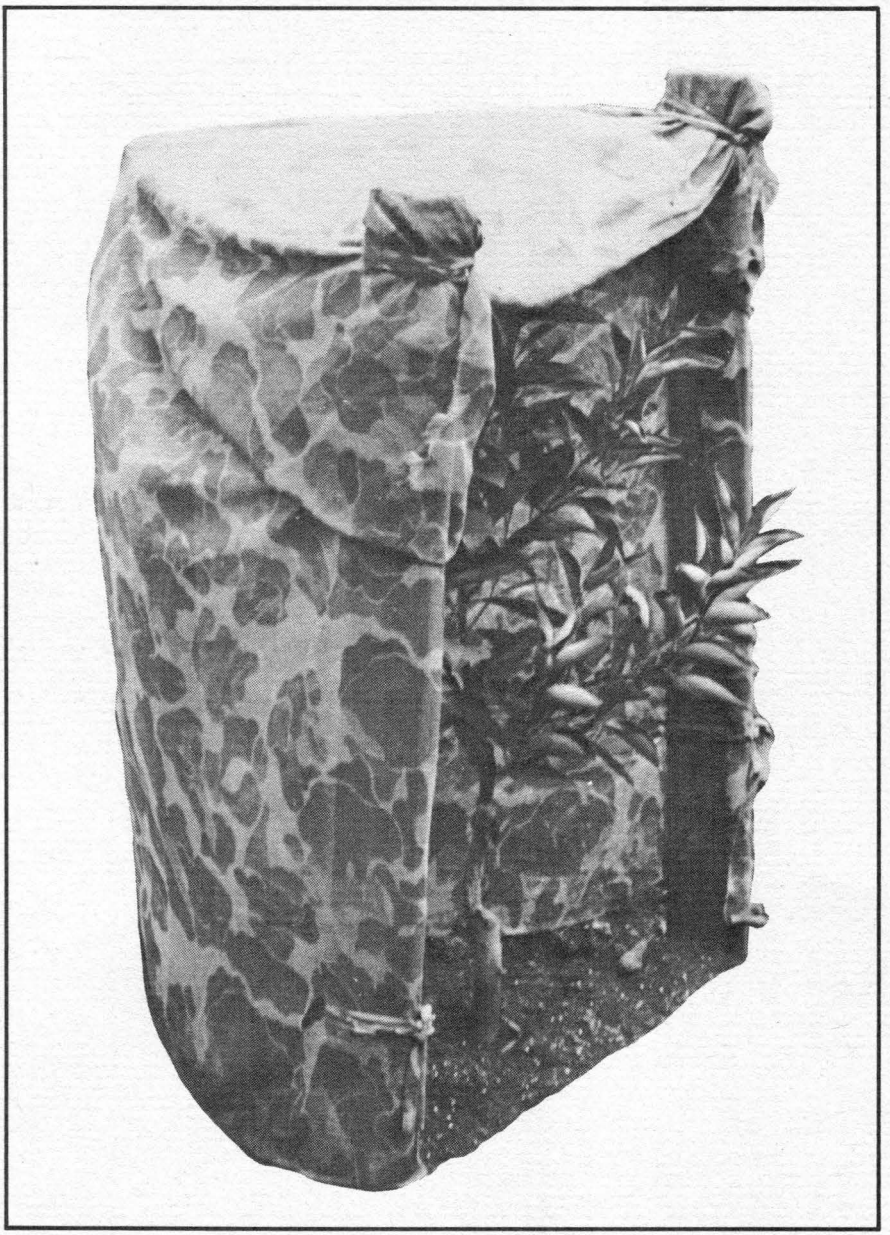
Cooperative Extension Service
University of Hawaii
Circular 473



Constructed Windbreaks

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CONSTRUCTED WINDBREAKS FOR HAWAII

Wade W. McCall and Harris M. Gitlin

Hawaii is in the northern limits of the Tropics where the northeasterly tradewinds blow 250 days or more each year. These winds are due to a permanent high pressure belt and average 8 to 20 miles per hour with occasional gusts of 40 miles per hour or more.

Storm winds may blow from other directions at any season, but most often in winter. Gusts from these "Kona" winds may reach 80 miles per hour, causing considerable damage to agricultural crops in various areas of the State.

Winds affect soil, crops, animals, and people, depending on the velocity and nature of the wind, the kind of crop, climatic factors and the protection provided.

Effect of Wind Velocity on Soil and Plant Environment

Wind effect	Wind velocity[1] (miles per hour)
Soil movement[2]	10-15
Reduced pollination[3]	10-15
Reduced activity of insects	10-15
Mechanical damage to plants[4]	15-20
Increase in transpiration and evaporation[5]	
1	Calm
2.2	5
3.8	10
4.9	15
5.7	20
6.3	30

[1]Wind velocity at level of the growing plant.

[2]Depends upon soil texture and structure. Sandy soils and soils with little or no structure erode at lower velocities.

[3]Blowing of flowers and pollen. Reduced activity of insects also reduces pollination.

[4]Mechanical damage to plants due to direct effect of wind, i.e., bending over, breaking branches, etc. Soil blowing will also damage plants due to abrasion by soil particles.

[5]Relative values based upon calm conditions.

ADVANTAGES AND DISADVANTAGES

Any permanent or temporary barrier used to reduce wind velocity and provide more favorable environmental conditions is known as a windbreak. Windbreaks protect plants from breakage and reduce loss of flowers and fruits. They protect animals from the discomfort of the wind and allow them to make more thrifty use of food and environment. Windbreaks also help protect people so that they may live and work more comfortably; they also may beautify and improve the environment.

Windbreaks produce the following effects:

- Reduce wind velocities to the leeward or downwind side of the windbreak up to 75 percent for a distance up to three times the height of the windbreak; up to 40 to 50 percent for a distance up to ten times the height of the windbreak; and up to 20 to 30 percent for a distance up to twenty times the height of the windbreak.
- Reduce evaporation in the protected area up to 40 percent. This conserves soil moisture and reduces transpiration stress on the plants.
- Increase temperatures in the protected areas up to 9 to 10 F.
- Reduce soil erosion and air pollution. Care must be taken not to channel wind through the windbreak so that erosion occurs in the area adjoining the windbreak.
- Reduce noise pollution by deadening noise from roadways, etc.
- Increase activity of bees, thereby increasing pollination and yields in the protected area.

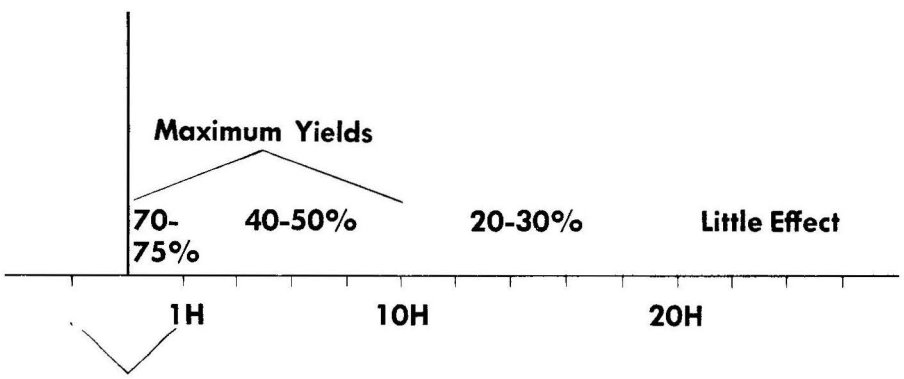


Figure 1. Effect of windbreaks on wind velocity and crop yields based on density of 75 to 100 percent. Reduction of 25 percent in density reduces effect from 40 to 50 percent at 10H to 33 to 45 percent at 7H.

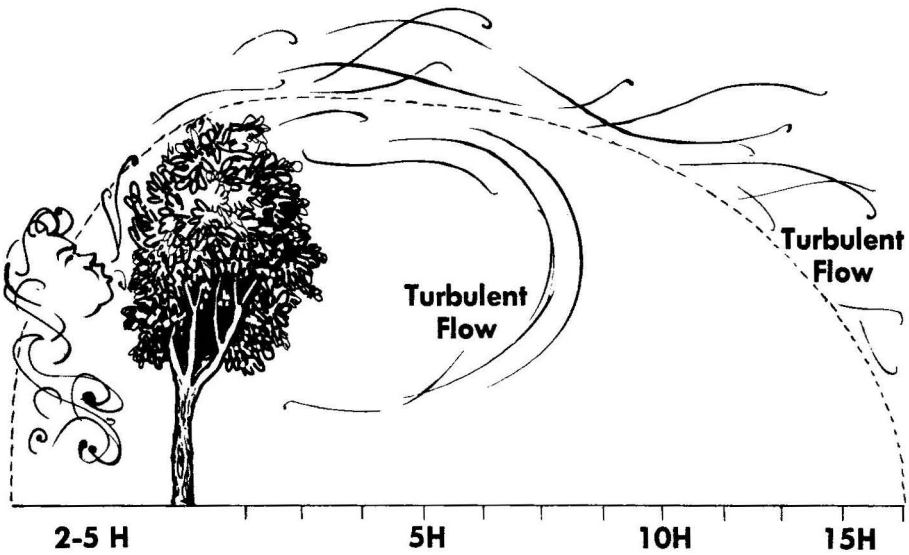


Figure 2. Effect of dense or solid windbreak on wind flow pattern. Note turbulent flow leeward of the windbreak; this may cause plant damage. (Vertical effects have been exaggerated to illustrate effect of wind.)

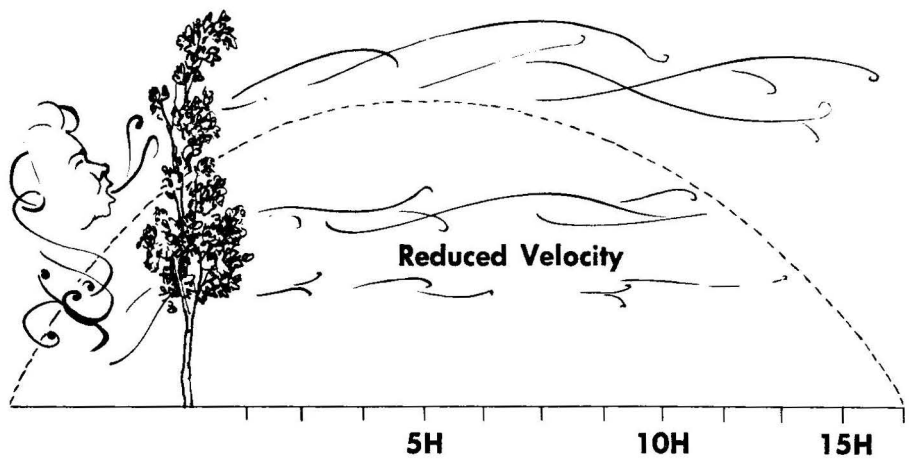


Figure 3. Effect of permeable (65 to 75 percent) windbreak on wind flow pattern. Wind velocities may be 25 to 30 percent higher at the same distance from the windbreak as compared with the dense or solid windbreak. (Vertical effects have been exaggerated to illustrate effect of wind.)

Some of the disadvantages are:

- Planted windbreaks compete with the roots of crop plants for moisture and nutrients. This reduces the yield for a distance up to 1½ times the height of the windbreak. Shading also may reduce yield.
- Certain types of disease may increase due to the higher moisture and temperature in the protected area.

KINDS OF WINDBREAKS

Windbreaks may consist of planted trees and shrubs, or they may be of an infinite number of materials. Fast growing plants may provide protection for a short period of time. Permanent windbreaks, used for long-term protection, usually consist of trees and shrubs that grow to relatively great heights and remain in place for years. Constructed windbreaks also may be permanent, but they are more often for temporary use until permanent windbreaks can be grown or until the crop has reached a stage at which it no longer needs protection.

Windbreaks may be dense or solid so that no wind can flow through, or they may be permeable to permit varying amounts of wind to pass through. Turbulence is created behind the solid windbreak, resulting in an irregular pattern of wind reduction. The permeable windbreak allows a more smooth and uniform pattern of winds and wind velocity.

TYPES OF CONSTRUCTED WINDBREAKS

Constructed windbreaks may be high or low, short or long, continuous or discontinuous. They also may be portable-flexible so that they can be moved from place to place as needed or be easily removed during harvesting operations.

Discontinuous windbreaks are commonly used for widely spaced trees and shrubs. Usually they are temporary and therefore can be made of any scrap materials. The most common continuous windbreak is the post and fence type.

The continuous post and fence is a series of posts partially buried for wind resistance. Wire, wire fencing, or wood may be hung between the posts to support the windbreak material, which may include shade cloth, plastic, palm fronds, poles or boards, sheet metal and snow fence.

The height and spacing of a windbreak depends on the use for which it is intended. Here are some guidelines for post size and spacing and depth posts should be buried, assuming the windbreak material is 30 to 50 percent porous.

- Posts should be at least ½ inch in diameter (small end) for each foot in height aboveground (3-inch diameter for a 6-foot height).

- Post spacing may be 6 feet in soils that provide little support, such as those derived from ash, to 10 or 12 feet in more firm soils. If you want to space posts farther apart, use larger posts or deeper placement.
- Depth of post hole should be about one-half the height of the post aboveground; for example, for a 6-foot high fence, the hole should be about 3 feet deep and the post 9 feet long.
- For heights above 6 feet it may be impractical to get the proper depth in some areas. Here are some alternatives:
  a) Add a plate or board (deadman) at each of the two pressure points.
  b) Wire the top of every second or third post to a ground anchor to windward.
  c) Use a more porous windbreak material, particularly in the upper half of the fence.
  d) Where wire is the supporting material, put a smooth curve in the fence line, curving the ends upwind.
  e) Anchor the posts in concrete to increase the bearing surface.

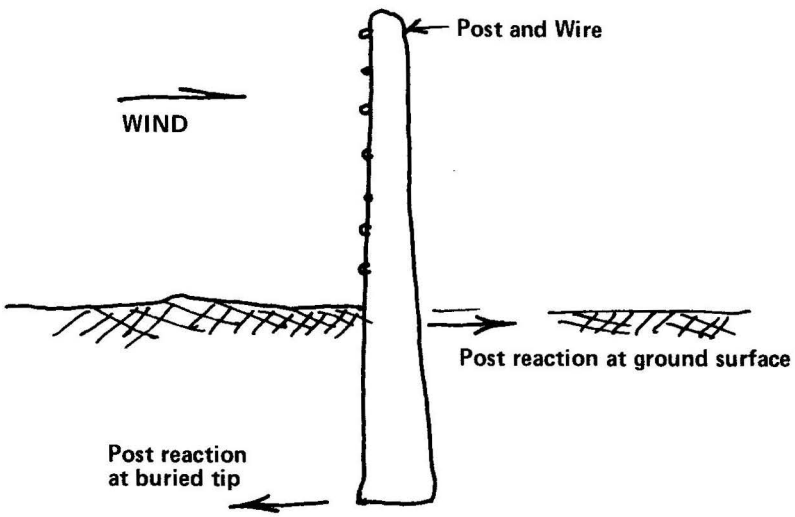
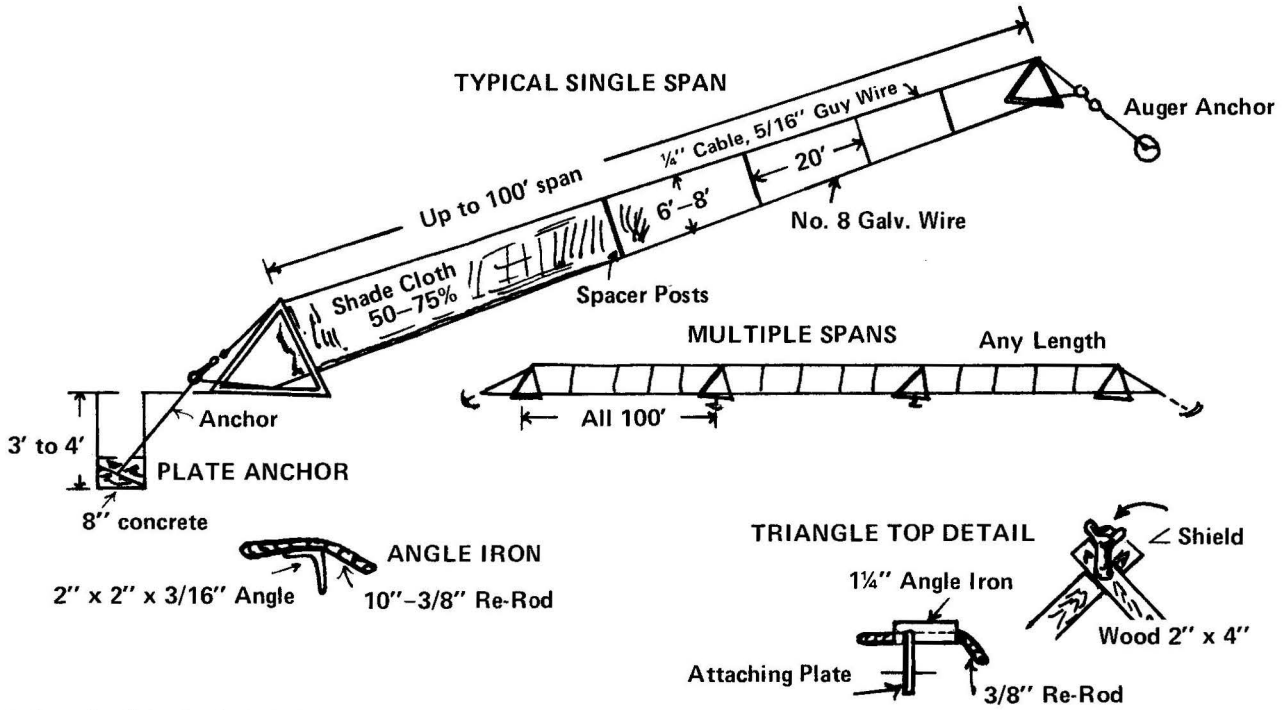


Figure 4. Continuous post and fence windbreak.
- **Increased wind velocity increases the load at the two reaction points.**
- **Increased height of windbreak increases the load at the two reaction points.**
- **Increased depth of post in the ground reduces the pressure at the reaction points.**
- **Increased post diameter reduces pressure on the two reaction points.**
- **Placing posts closer together reduces pressure on individual posts.**
- **If post line is uneven, neighboring posts will help support a weak one.**



Attach ends of shade-cloth to triangles.
Spacer Posts attach to cable and wire but do not penetrate ground.
Allow 3' maximum sag in cable; wire is tight.
Cable at least 4000 lbs. maximum capacity.

Figure 5. Principles of construction for portable-flexible windbreak.

Portable-flexible windbreaks will give temporary protection to large numbers of plants. The University of Hawaii College of Tropical Agriculture has developed such an "instant windbreak." It was designed primarily for vegetable growers who 1) do not want to give internal space or water to planted windbreaks, 2) have roadways in their crop areas about every 100 feet, 3) do not need windbreaks continuously in one place and prefer a cleared area when tilling and planting.

This windbreak is made of plastic shade cloth (50 to 70 percent shade) with all edges sewn and grommets at 18-inch to 2-foot intervals. The material is supported by a cable at the top and a wire at the bottom, both attached to end triangles and permanent or removable anchors. Spacer posts, located every 20 feet along the span, are attached to the cable and wire but do not extend into the ground. These posts act as spreaders to keep the shade cloth from bellying in the wind. Under windy condition, the bottom wire remains in nearly a straight line, and the top cable will sag downwind a maximum of 3 feet in the middle. A single span may be up to 100 feet long; if longer, add another triangle and anchor. The cable and wire can be quickly disconnected from the anchors, and two men can readily roll and carry the 100-foot length to another site.

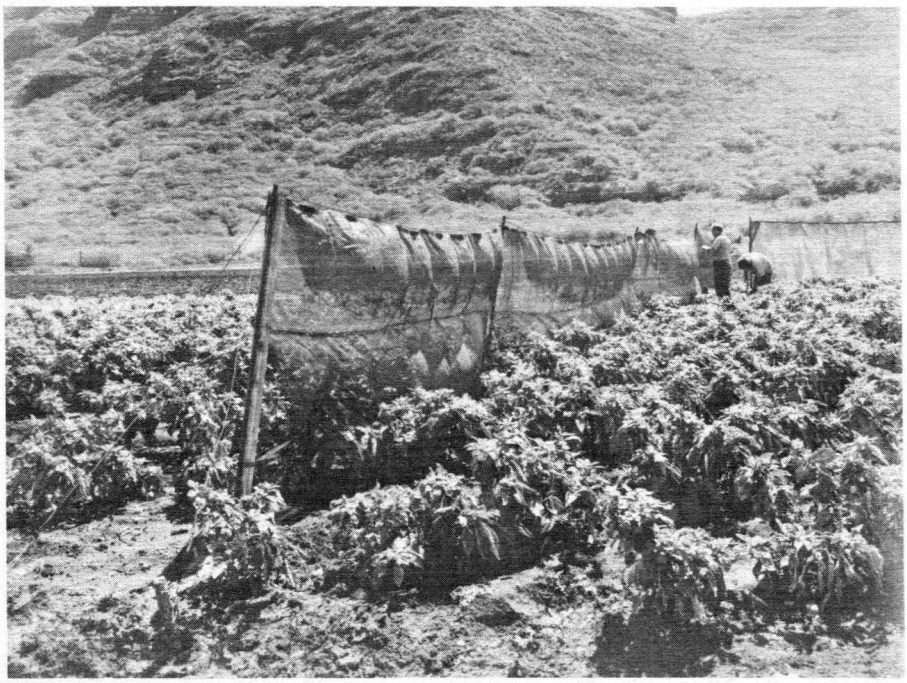


Figure 6. Portable-flexible windbreak, early design.

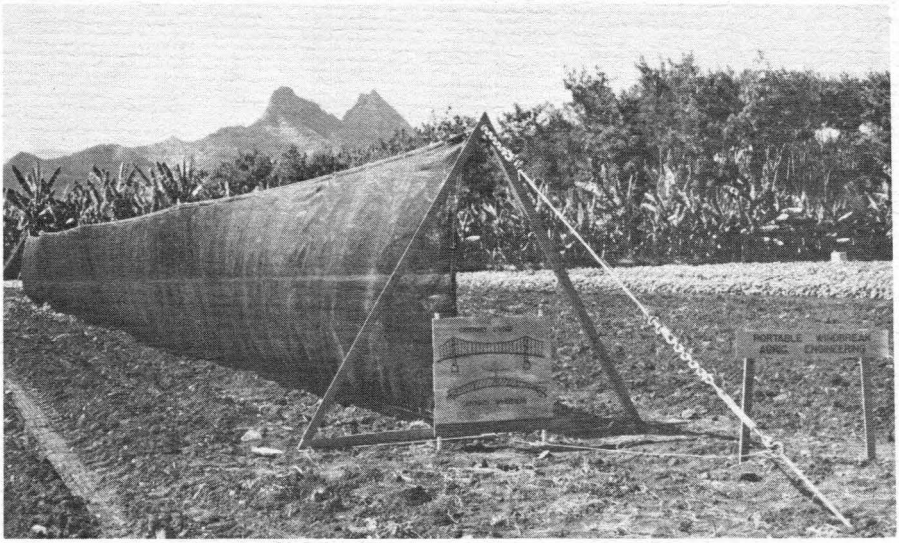


Figure 7. Portable-flexible windbreak with support triangles added.

MATERIALS USED FOR CONSTRUCTED WINDBREAKS

Materials for windbreaks should allow some wind to pass through. Porosity influences the wind load.

When selecting material for constructed windbreaks, consider the following:

- What protection is needed in the area?
- What materials are available in the area?
- Will soil conditions provide the necessary support for constructed windbreaks?
- Is the windbreak to be temporary or permanent?
- Should "instant windbreaks" be constructed until planted windbreaks can be grown or until crops become established?
- What will the materials cost?
- How much time and labor will be required to construct and/or remove the windbreak?
- How often will the windbreak need maintenance and repairs, and how much will it cost?

The cost of construction varies from one island to another in Hawaii, due to differences in available supplies and labor costs for construction. The cheaper windbreaks are those which the farmer, grower or homemaker can build himself.

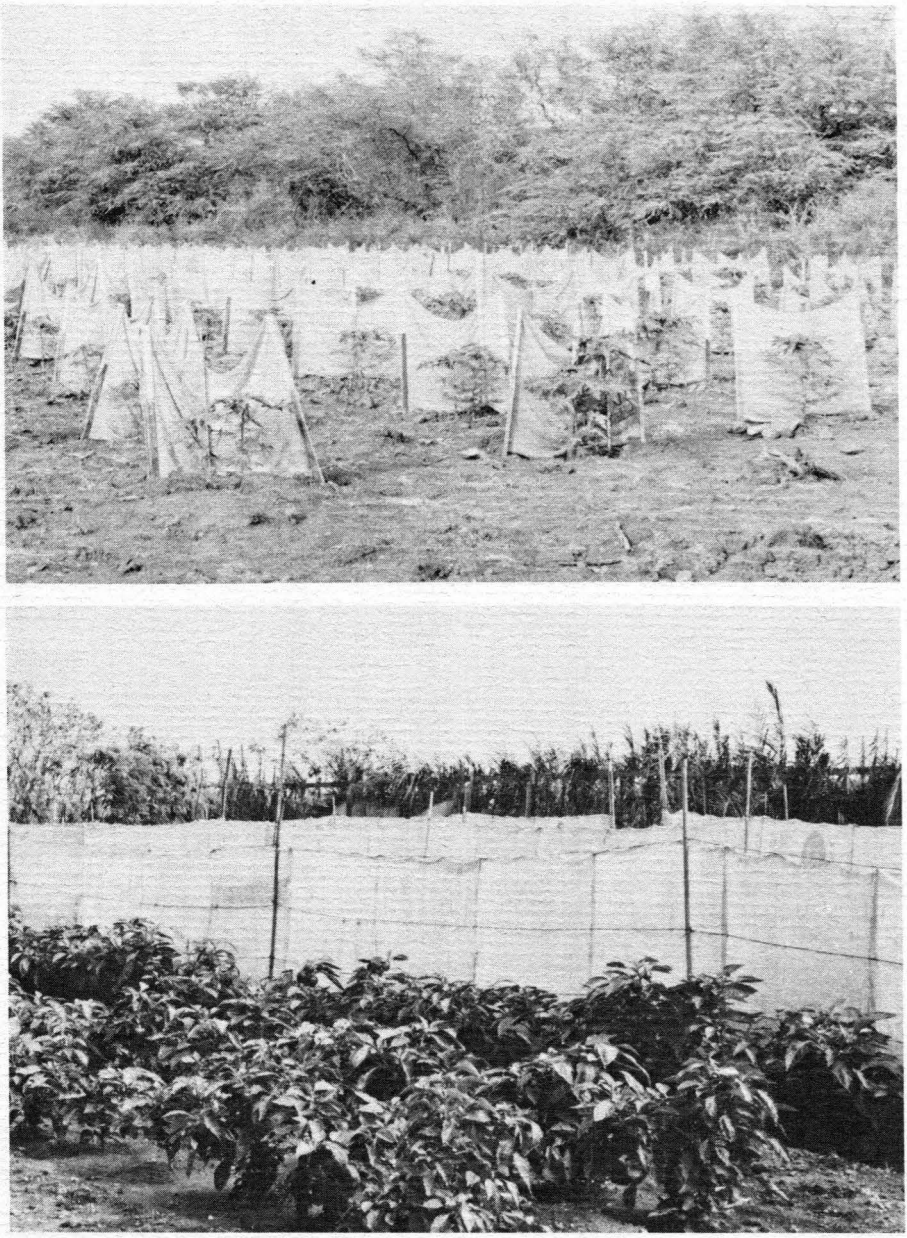


Figure 8. Burlap bags, such as empty feed bags, may be cleaned and mounted on suitable supports in a continuous or noncontinuous design. Such bags are porous enough to allow some wind through but still provide necessary protection to plants and animals. They are used in many parts of Hawaii for individual trees or plants.

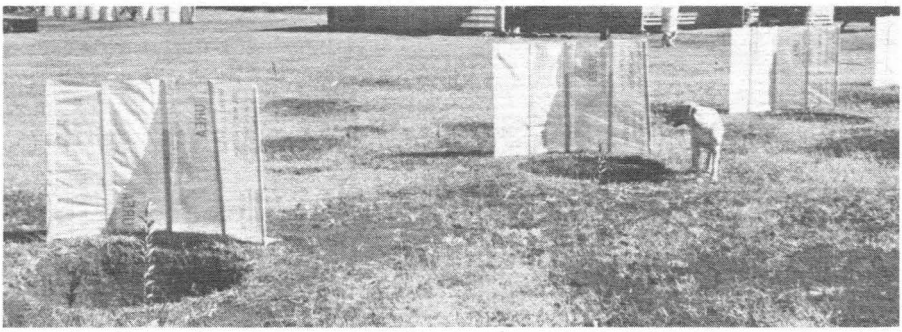


Figure 9. Plastic bags, such as those fertilizers are sold in, present a solid barrier to the wind and are less effective than burlap.

Figure 10. Palm fronds, grown in many areas of Hawaii, make excellent windbreaks. The large fronds may be split in half and the individual leaves woven together. Or the fronds may be nailed to frames or interwoven in wire supports. They are porous enough to allow part of the wind through and yet provide protection for the area. They are often used in combination with other materials to protect relatively large areas. They are most effective with low growing plants. They are also used extensively to provide wind protection, noise control, and privacy for homes.

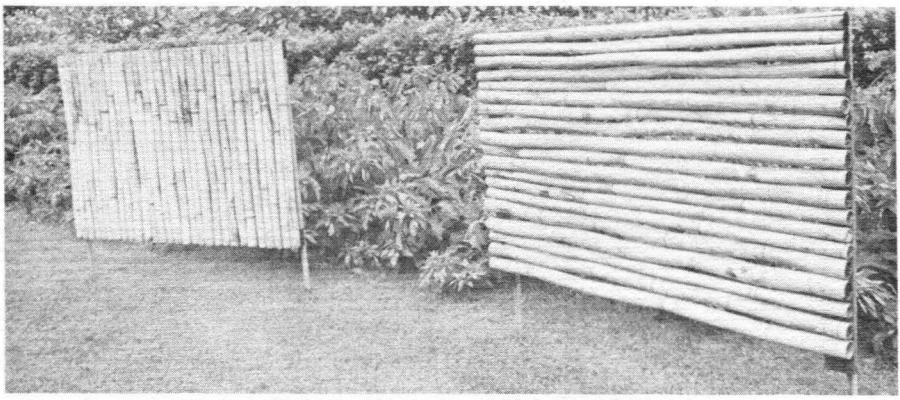


Figure 11. Bamboo stalks make an excellent windbreak but are difficult to obtain in many parts of Hawaii. The stalks usually are split for convenience in construction. They may be used to protect individual plants, in panels, or in long fences to protect relatively large areas. Bamboo is decorative and provides an attractive privacy screen for homeowners.

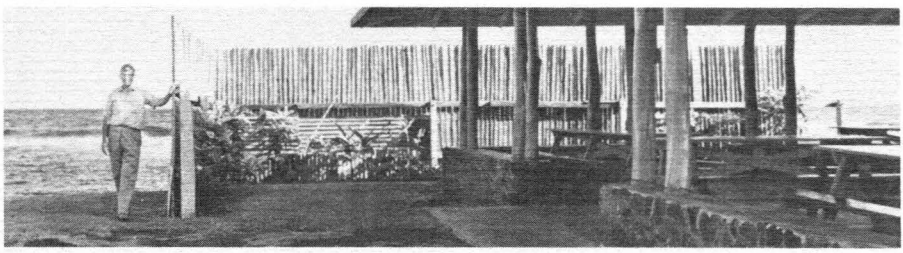


Figure 12. Sisal grows in abundance in some areas of Hawaii. The large long flowerstalk makes an excellent construction material after it dries and is split in half. It makes an attractive windbreak that also provides privacy.

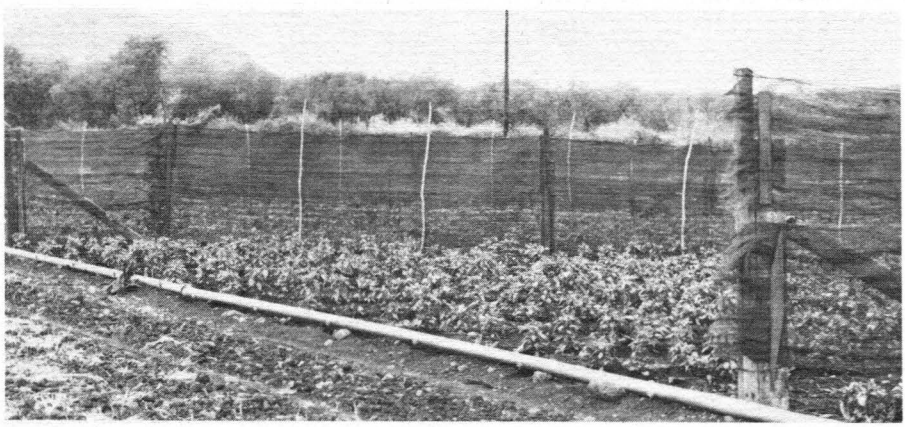
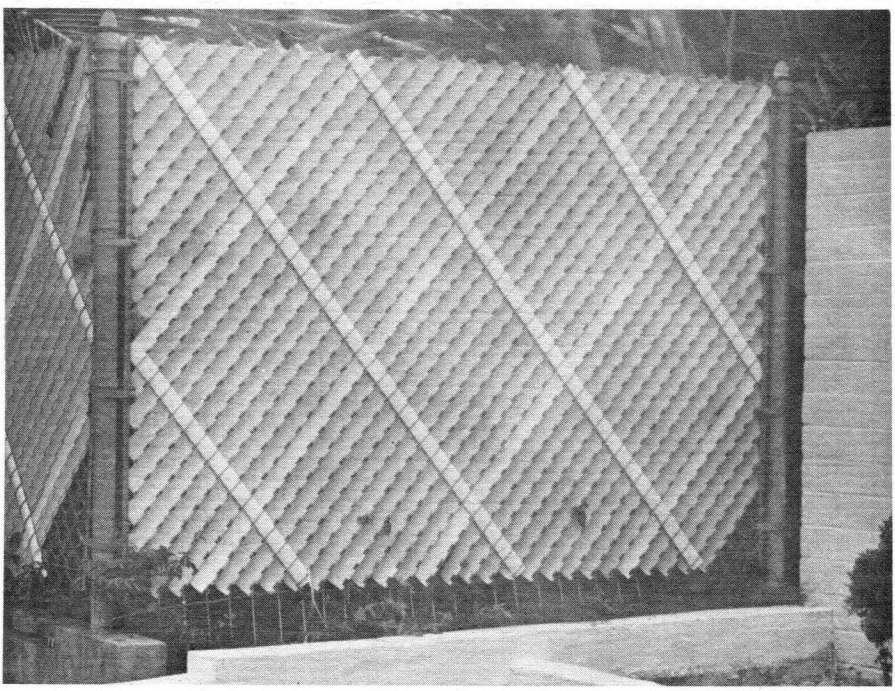


Figure 13. Camouflage nets and cloth are occasionally available in Hawaii as war surplus materials. These materials are quite porous and not as good as plastic windbreaks, but they are cheap and easy to construct.

Figure 14 (left). Parachute cloth makes a satisfactory material for windbreaks. It is most often used as protection for individual plants. It has some permeability, comes in several different colors, is relatively expensive, but is in limited supply in Hawaii.

Figure 15 (below). Chain-link fence woven with aluminum strips is used quite widely to provide privacy in urban areas. It makes an excellent windbreak as it has enough porosity to allow some wind through yet provides adequate protection for plants and people. This is an expensive windbreak material.



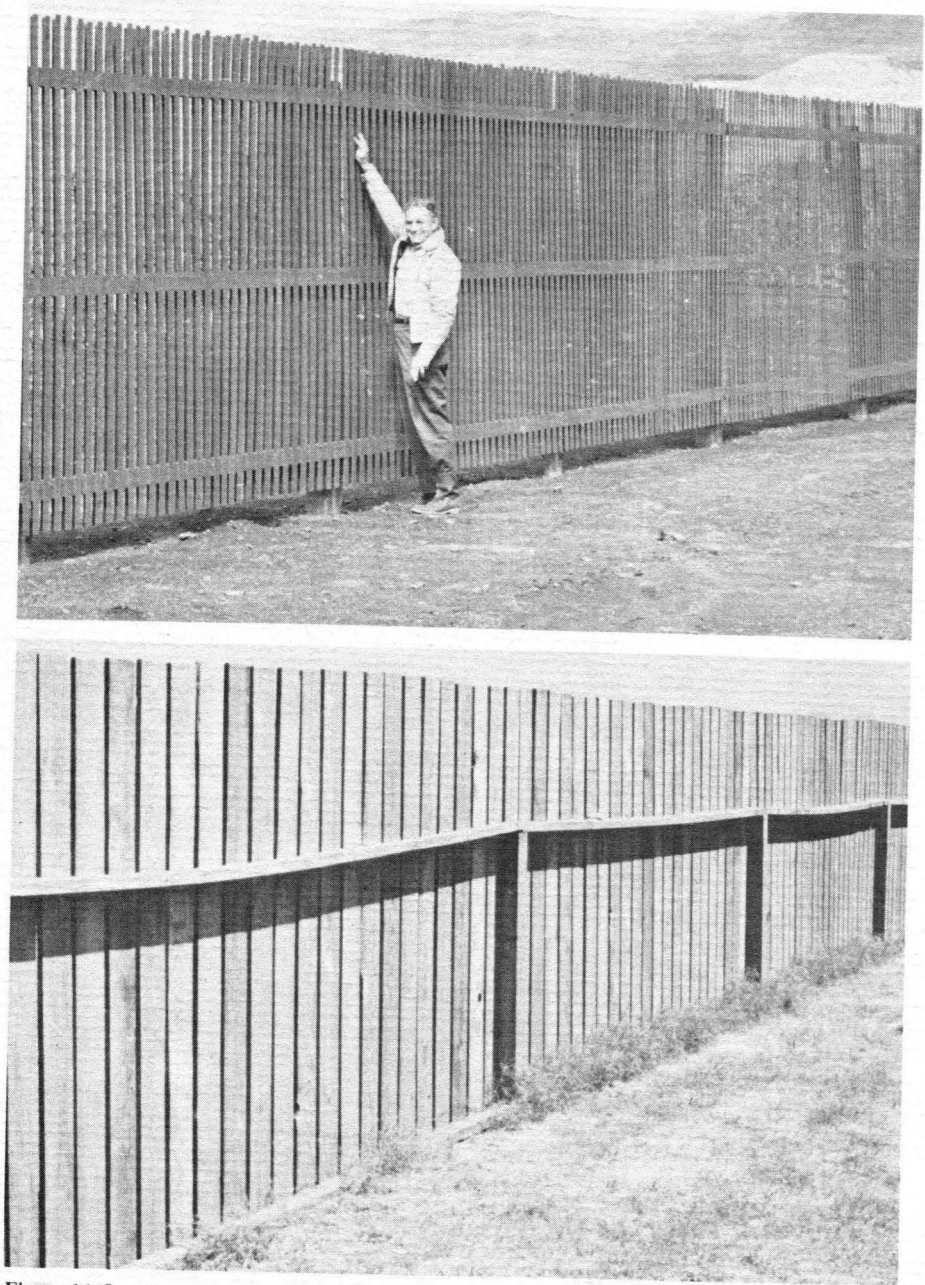


Figure 16. Lumber makes an excellent barrier to the wind or to provide privacy. Windbreaks usually are made of slats placed on alternate sides of the support, or of boards with narrow openings between each, or woven, or made from sheets of plywood. Many beautiful designs may be made with lumber for both temporary or permanent windbreaks.

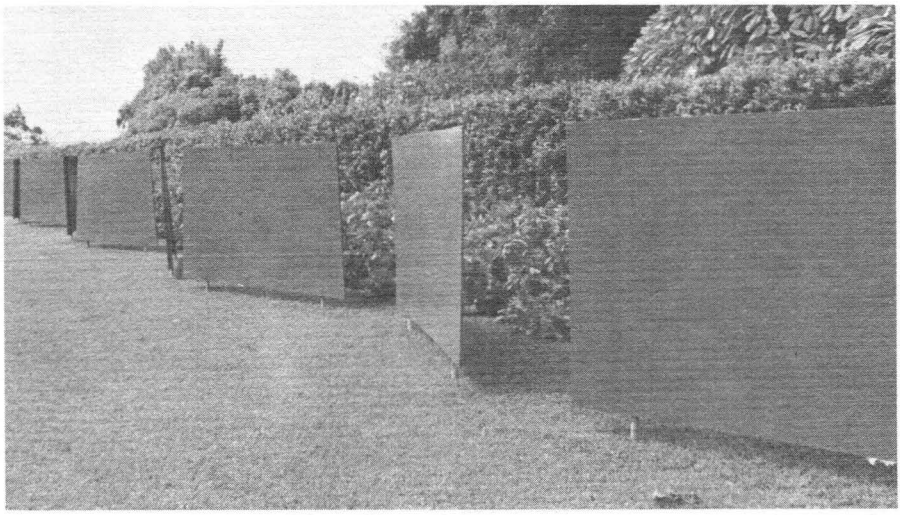


Figure 17. Wooden panels used to provide temporary wind protection. These panels are painted to enhance their aesthetic value.

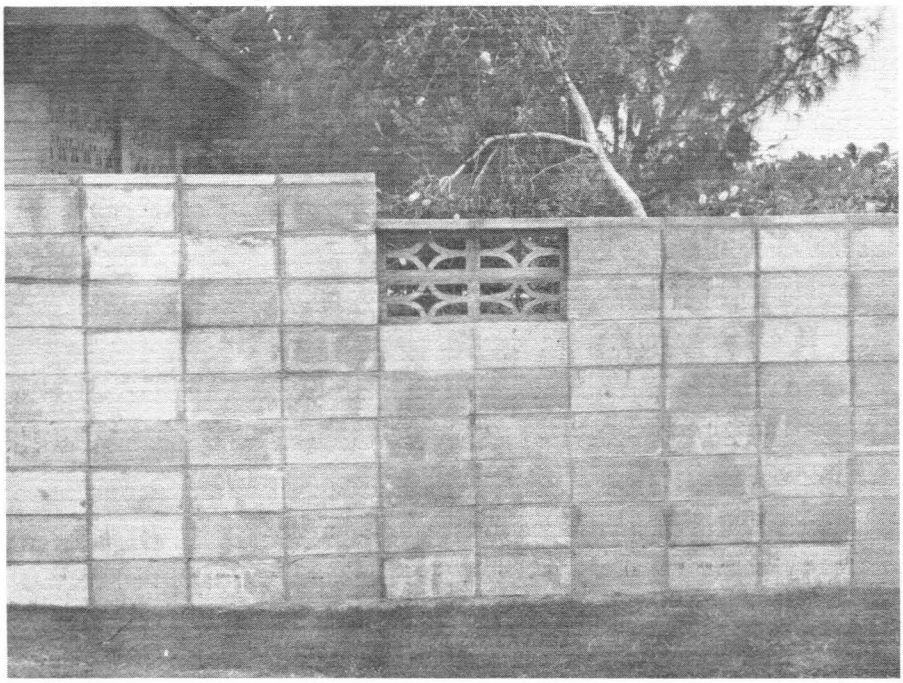


Figure 18. Masonry is used primarily to provide privacy, wind protection and noise control around homes. Generally it has little porosity as this destroys its effectiveness in providing privacy. This type of construction is very expensive, but its value as a windbreak should not be overlooked.

Other types of windbreaks include:

Woven fences or snow fences may be made of slats of wood woven in wire supports. Usually these have such wide spaces between each slat that they provide only moderate to slight protection.

Scrap lumber and scrap metal salvaged from old buildings or fences may be used for windbreaks. The pieces should be spaced to allow some wind through. The windbreak should be high enough to provide protection for the area. Such scraps usually are unattractive and used only for temporary windbreaks.

Sheet metal of various types makes effective, attractive windbreaks if properly maintained. It should be constructed to allow some permeability to the wind. It is one of the more expensive materials for windbreaks.

MAINTENANCE

Constructed windbreaks need to be maintained to remain effective. Repair them as needed by replacing broken, rotted or defective materials. Protect them from mechanical damage caused by animals, automobiles, farm machinery, etc. Those that will burn should be protected from fire. Keep the windbreaks free of weeds and undesirable vegetation as these are unsightly and often are sources of pest infestations. Many constructed windbreaks should be kept painted to protect the material and to enhance the aesthetic value. Occasional inspection tours should be made to check wires and cables for tightness and materials for breaks or tears.

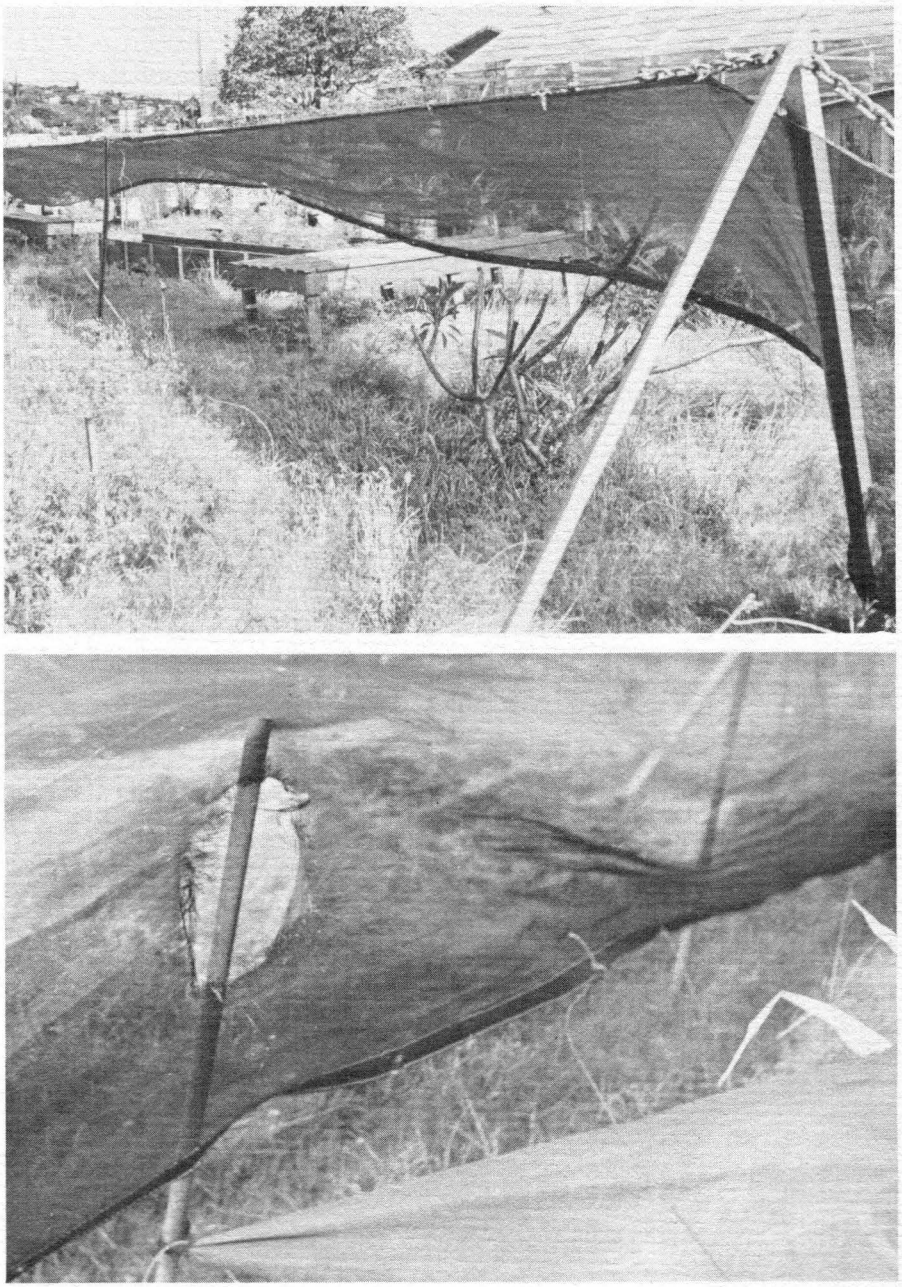


Figure 19. Maintenance of constructed windbreaks is necessary to keep them effective. Note how rubbing broke the bottom wire and destroyed the effectiveness of the windbreak (top). Holes or structural failures should be repaired to maintain effectiveness.

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